

TABLE OF CONTENTS

CONTENTS	PAGE
SUMMARY	Summary - 1
INTRODUCTION - CHAPTER 1	1
Changes Between Draft and Final	1
Project Area Overview	1
Purpose of And Need For The Action	6
Element 1- Water Quality	6
Element 2- Recreational Fishery	8
Proposed Action	10
Decisions To Be Made Based On This Analysis	13
Relationship To Forest Plans, The Project Record, Roads Analysis and The Diamond Lake/Lemolo Lake Watershed Analysis	13
Interagency Cooperation	14
Scoping	15
Significant Issues	16
Other Issues	18
INTRODUCTION - CHAPTER 2	21
Changes Between Draft and Final	21
Alternatives Considered In Detail	21
Alternative 1	21
Alternative 2	22
Alternative 3	31
Alternative 4	32
Alternative 5	37
Best Management Practices, Management Requirements, Mitigation Measures, And Monitoring	42
Permits And Authorizations	50
Summary And Comparison of Alternatives	51
Alternatives Considered, But Eliminated From Detailed Study	63
INTRODUCTION - CHAPTER 3	71
Changes Between Draft and Final	71
Activities That Contribute To Cumulative Effects.	72
Geological Environment	83
Aquatic Environment	85
Water Quality Regulations And Beneficial Uses	85
Aquatic Conservation Strategy	87
<i>Surface Water - Lake Ecology</i>	89
Background And Limnological Investigations	89
Lake Morphometry And Sediments	91
Conclusions	99
Water Temperature And Thermal Properties	99
Conclusions	102
Water Quality (Dissolved Oxygen, Nutrients, Alkalinity And pH)	102

	PAGE
Conclusions	120
Light And Transparency	123
Conclusions	127
Surface Water - Stream Ecology	128
Streamflow Regime	128
Conclusions	140
Water Quality	141
Conclusions	150
Dissolved Oxygen And pH	151
Aquatic Conservation Strategy - Water Quality	160
Channel Morphology And Fluvial Erosion	160
Conclusions	166
Aquatic Biology	169
Phytoplankton And Primary Production	169
Conclusions	181
Aquatic Macrophytes.....	182
Conclusions	189
Zooplankton	190
Conclusions And ACS Discussion	202
Benthic Organisms.....	205
Conclusions And ACS Discussion	215
Fish And Fish Habitat	216
Forest Plan Standards and Guidelines and Riparian Prescription C2-I.....	237
Potential Cumulative Effects Common To All Alternatives	242
Conclusions	243
ACS Discussion.....	246
Biological Evaluation of PETS Aquatic Species	247
Essential Fish Habitat	248
Groundwater	255
Groundwater Investigation.....	257
Water Quality - Water Chemistry.....	264
Conclusions	267
Groundwater Quantity - Groundwater Discharge And Recharge	268
Conclusions	270
Terrestrial Environment	272
Terrestrial Vegetation	272
Noxious Weeds.....	273
Threatened, Endangered, And Sensitive Plants	275
Former Survey And Manage	280
Wetland Plant Ecology.....	286
Summary of Effects To Wetland Plants.....	294
Wildlife	294
Background: Toxins And Wildlife.....	294
PETS Species	298
Northern Bald Eagle	304
Conclusions	310
Former Survey And Manage Species	328
Crater Lake Tightcoil Snail	330

	PAGE
Conclusions	332
Management Indicator Species	333
Waterbirds.....	339
Reptiles And Amphibians	342
Bats	345
Other Mammals	348
Summary	350
Social Environment	351
<i>Human Health Risk</i>	351
Toxicity of Algae Blooms To Humans	351
Toxicity of Rotenone To Humans	354
Toxic Algal Blooms	358
Rotenone.....	363
Overview And Comparison Of Toxicity Risks	371
<i>Recreation</i>	372
2003 Recreation Survey Data	375
Sense of Place	376
Recreation Visitation	380
Summary Of Alternatives Effects On Recreation	394
<i>Economics</i>	395
Regional Population And Economic Indicators	396
Economic Structure	396
Diamond Lake Developed Recreation Facilities	398
Effects Of The Fishery Decline On Local Economic Activity	402
Effects On Local Economic Activity	403
Effects On Diamond Lake Developed Recreation Facilities	406
Project Implementation Costs.....	407
Cumulative Effects Associated with Contingency Plans	409
Unavoidable Adverse Impacts	412
Irreversible and Irrecoverable Commitments of Resources.....	414
Short Term and Long Term Productivity.....	414
<i>Specifically Required Disclosures</i>	415
Public and Worker Safety	415
Cultural Resources	415
Unique Habitats	415
Wetlands and Floodplains.....	415
Prime Farmlands, Rangelands, forestlands or Parklands.....	415
Potential or Unusual Expenditures of Energy	415
Conflicts with Plans or Policies of Other Jurisdictions	415
Consumers, Civil Rights, Minority Groups, and Women	416
Environmental Justice	416
INTRODUCTION - CHAPTER 4	417
Changes Between Draft and Final	417
Diamond Lake Restoration Project Interdisciplinary Team	417
Others Contributing Specialists Reports	419
Other Contributors And Reviewers	420
Consultation With Tribes	421
Regulatory Agencies That Were Consulted	422
List Of Persons And Agencies Who Participated In The Planning Process Either	

	PAGE
At Open Houses, Public Forums, Meetings, Field Trips Or Who Wrote Comment Letters	422
Distribution Of The Draft/Final EIS	431
Diamond Lake Restoration Public Involvement Process	434
INTRODUCTION - CHAPTER 5	437
Response to Comments.....	437
Public Involvement Following the Comment Period	579

List of Tables..... PAGE

Table 1. Required Permits/Authorization for Alternatives 2, 3, and 5 and Connected Actions	51
Table 2. Authorizations for Alternative 4.	51
Table 3. Comparison of Alternatives at Meeting Water Quality Element 1 of Purpose and Need	52
Table 4. Comparison of Alternatives at Meeting Recreational Fishery Element 2 of Purpose and Need.....	55
Table 5. Comparison of Alternatives at Responding to Fish Stocking Issue 1	57
Table 6. Comparison of Alternatives at Responding to Non-Target Species Issue 2....	57
Table 7. Comparison of Alternatives at Responding to Water Quality Issue 3	58
Table 8. Comparison of Alternatives at Responding to Wetland Ecology Issue 4	61
Table 9. Past Management Activities in the Cumulative Effects Analysis Area.	73
Table 10. Present Management Activities in the Cumulative Effects Analysis Area....	78
Table 11. Reasonably Foreseeable Management Activities in the Cumulative Effects Analysis Area.	80
Table 12. Water Quality Limited Streams and Water Bodies Within and Downstream of the Project Boundary	86
Table 13. Morphometry of Diamond Lake.....	91
Table 14. Summary of Water Quality Data for Diamond Lake	102
Table 15. Persistence of Rotenone and Other Organic Compounds in Water and Sediment Impoundments Treated with 2 mg/L Rotenone Formulation	115
Table 16. Comparison of Alternatives Effects on Summer pH in Diamond Lake	122
Table 17. Comparison of Alternatives Effects on pH in Downstream Water Bodies....	155
Table 18. Lake Creek Stream Channel Characteristic	161
Table 19. Comparison of Alternatives Effects on Stream Channel Morphology	167
Table 20. Summary of Alternative Effects on Zooplankton Populations	204
Table 21. Summary of Alternative Effects on Benthic Organism Populations.....	216
Table 22. Early Stocking in Diamond Lake	220
Table 23. Diamond Lake Fish Stocking Data from 1955-1990.....	222
Table 24. Recent Fish Stocking Information for Diamond Lake.	224
Table 25. Summary of Alternative Effects on Fish Populations	244
Table 26. Biological Evaluation and Effects Determinations for PETS Aquatic Species	248
Table 27. Matrix of Pathways and Indicators for the Middle North Umpqua 5 th Field Watershed.....	254
Table 28. Actual or Predicted Groundwater Flow Reversal for Diamond Lake Monitoring Wells	262
Table 29. Comparison of Alternatives Effects on Groundwater	271

	PAGE
Table 30. Sensitive Species with Potential Habitat in the Project Area	276
Table 31. Plant Species Occurring in the South Shore Diamond Lake Wetland Complex	288
Table 32. Summary of Effects of Each Alternative to Wetland Plants in Diamond Lake	294
Table 33. Bird Mortality from Algal Toxins	295
Table 34. Prefield Review and Biological Evaluation Summary Table.	300
Table 35. Reproductive History of Bald Eagle Nest Sites at Diamond Lake	306
Table 36. Waterbirds Detected in Numbers Greater than 10 During the 2000-2002 Surveys at the South Shore Picnic Area and South Shore Meadows Survey Points on Diamond Lake	340
Table 37. Potential Bat Species at Diamond Lake and their Habits and Habitats	346
Table 38. Other Mammals at Diamond Lake and their Habits and Habitats	348
Table 39. Determination of Effects to Threatened, Endangered, and Sensitive Wildlife Species	350
Table 40. Summary of the Toxicity Information Available on Algae Toxins	353
Table 41. Human Health Standards, Risk-based Safe Levels, and Detection Limits for Rotenone and Other Associated Ingredients in Drinking Water.	356
Table 42. Summary of Exposure Risks to the Algal Toxins Associated with the Diamond Lake Restoration	362
Table 43. Comparison of Alternatives for Potential Worst-Case Human Health Impacts	371
Table 44. Summary Information for Six SOP Units in the Diamond Lake Restoration Project Area	376
Table 45. Annual Occupancy at Diamond Lake Campgrounds from 1989-2003	380
Table 46. Annual Angler Trips at Diamond Lake	381
Table 47. Alternative 1: Expected Changes in the Diamond Lake Recreational Fishery from 2004-2009	384
Table 48. Alternative 2: Expected Changes in the Diamond Lake Recreational Fishery from 2004-2009	387
Table 48a. Alternatives 2 and 5: Forecasted Changes in the Diamond Lake Recreational Fishery Associated with Contingency Plan	389
Table 49. Alternative 3: Expected Changes in the Diamond Lake Recreational Fishery from 2004-2009	390
Table 49a. Alternative 3: Forecasted Changes in the Diamond Lake Recreational Fishery Associated with Contingency Plan	391
Table 50. Alternative 4: Expected Changes in the Diamond Lake Recreational Fishery from 2004-2009	392
Table 50a. Alternative 4: Forecasted Changes in the Diamond Lake Recreational Fishery Associated with Contingency Plan	393
Table 51. Summary of Alternative Effects on Recreation Use	394
Table 52. Population and economic indicators for Oregon and the three Counties in the Diamond Lake Economic Area.....	396
Table 53. 2001 Employment by Industry for Oregon and the three Counties in the Diamond Lake Economic Area.....	397
Table 54. Travel Impacts for Oregon and the three Counties in the Diamond Lake Economic Area.....	398
Table 55. Diamond Lake Forest Service Campground Revenues	399
Table 56. Angler trips at Diamond Lake.....	402

	PAGE
Table 57. Trip Related Per Day Angler Expenditure Profiles for Expenditures Within the Local Area.	403
Table 58. Estimated Local Economic Activity Associated with the Predicted Number of Total Angler Trips by Alternative	405
Table 59. Estimated Project Implementation Costs by Alternative	408
Table 60. Estimated local economic activity associated with the predicted number of total angler trips by action alternative, if the contingency plan is implemented. .	410
Table 61. Estimated contingency plan implementation costs (5 years, 2012-2016)	411
Table 62. Estimated total costs if contingency plan is implemented.	412
Table 63. Comments received on the DEIS, by subject of concern, and the Forest Service’s Response.....	441

List of Figures PAGE

Figure 1. Diamond Lake at the Base of Mt. Thielsen.....	1
Figure 2. Project Area Location on the Diamond Lake Ranger District, Umpqua National Forest.	2
Figure 3. Diamond Lake Restoration Project Area Within the Analysis Area	3
Figure 4. Diamond Lake Restoration Project Area.....	4
Figure 4a. Referenced Areas in the Diamond Lake Project Area.....	40
Figure 4b. Referenced Areas in or Adjacent to the Diamond Lake Project Area	41
Figure 5. Diamond Lake Bathymetric Map	92
Figure 6. Diamond Lake Area by Depth	93
Figure 7. Sediment Accumulation Rate.....	94
Figure 8. Area of Exposed Sediment at Time of Maximum Draw Down.	96
Figure 9. Temperature Vertical Profile Showing Epilimnion, Metalimnion, and Hypolimnion During Typical Summer Thermal Stratification.	100
Figure 10. Typical seasonal temperature profiles from Diamond Lake	101
Figure 11. Dissolve Oxygen Profiles Showing Seasonal Changes in the Hypolimnion...	104
Figure 12. Average Concentration of Total Dissolved Phosphorus and Orthophosphate 1992 - 2002	106
Figure 13. Typical seasonal changes in the concentration of ammonia (NH ₃) and dissolved oxygen in the hypolimnion of Diamond Lake in 2001	110
Figure 14. Average Values Summer Season Values of Total Kjeldahl Nitrogen and Nitrate in Epilimnion of Diamond Lake, and the Streams; Lake Creek, Silent Creek and Short Creek	11
Figure 15. Diamond Lake pH Vertical Profiles Measured by DEQ in 2001	113
Figure 16. Concentration of chlorophyll <i>a</i> (0-1 m depth) and Secchi Disk Transparency (Summer 2002).....	124
Figure 17. Lake Creek Historical Hydrograph for Mean Monthly Streamflow.....	130
Figure 18. Lake Creek Mean-Daily Streamflow for the Period of Record in Comparison to the 1.5 Year Bankfull Flow of 110 Cubic Feet per Second.....	131
Figure 19. . Referenced Locations on Lake Creek and the Environmental Effects of a Lake Draw Down.....	134
Figure 20. Estimated Duration of the Draw Down Phase with Higher Streamflow in Lake Creek to Drain Diamond Lake	135

	PAGE
Figure 21. Simulated Mean Daily Flow for Alternatives 2 and 3 over the Project Period in Comparison to Actual Mean Daily Flow from the Lake Creek Gaging Station	136
Figure 22. Mean Monthly Flow at North Umpqua River Below Lemolo Dam, USGS Gaging Station 14313500 Before and After Dam Operation	140
Figure 23. Nitrogen and Phosphorus Concentrations (mg/L) in Lake Creek at Outlet and Mouth	145
Figure 24. Phytoplankton Biovolume During 2003	170
Figure 25. Phytoplankton Percent Composition During 2003	170
Figure 26. Phytoplankton Primary Production Variation Over Time and Depth	177
Figure 27. Distribution of Aquatic Macrophytes in Diamond Lake Based Upon Hydroacoustic Sampling in 2002	183
Figure 28. Representative Examples (and relative sizes) of the Three Major Groups of Zooplankton in Freshwaters	190
Figure 29. The Relationship Between Zooplankton and Fish in Diamond Lake (modeled from data collected at Diamond Lake).....	193
Figure 30. Benthic Production in Diamond Lake From 1946 to 1977	206
Figure 31. Fish Species Currently in Diamond Lake.	219
Figure 32. Geologic Map of Diamond Lake, Showing the Drift, Lacustrine, and Ash Flow Deposits.	257
Figure 33. Shallow and Deep Aquifers	258
Figure 34. Ground Water Monitoring Well Locations in the Shallow Unconfined Aquifer at Diamond Lake	260
Figure 35. Changes in Ground Water Flow Patterns Around a Lake	261
Figure 36. Hydrographs for Teal and Horse Lakes	270
Figure 37. Rare Plant Sites Within the Project Area	277
Figure 38. Goblin’s Gold Moss	282
Figure 39. California Elfin Saddle	282
Figure 40. Wetlands Within the Project Area	286
Figure 41. South Shore Wetland Complex at Diamond Lake	289
Figure 42. Wetland complex bordering Lemolo Lake illustrates the abundance of Bog Birch	290
Figure 43. Map Showing Affected Area of Lake Creek From Drying After Draw Down Is Complete.....	292
Figure 44. Fishing boats at Diamond Lake	373
Figure 45. Sense of Place Units within the Diamond Lake Restoration Project Area ..	379
Figure 46. Declining Angler Trips at Diamond Lake	382
Figure 47. Diamond Lake Resort Total Sales for the Shoulder (April-June, Sept. & Oct), Peak (July & August) and Total Fishing Season (April-October), 1986-2002	400
Figure 48. Diamond Lake Resort Marina Sales for the Shoulder (April-June, Sept. & Oct), Peak (July & August) and Total Fishing Season (April-October), 1986-2002	401
REFERENCES.....	References - 1
GLOSSARY	Glossary - 1
ACRONYMS.....	Acronyms - 1

	PAGE
APPENDIX AA	1
APPENDIX BB	Plans - 1
APPENDIX CC	Alt 4 Plan - 1
 APPENDICES - available on-line, via CD, or by request (for paper copy).	
Agency Roles and Responsibilities.....	Appendix - A
Best Management Practices Checklist	Appendix - B
Terrestrial Specialists Reports	Appendix - C
Aquatic Specialists Reports	Appendix - D
Social Specialists Reports	Appendix - E